

CLAIMS

1. Intramedullary nail (10, 110, 210, 310, 410, 510, 610) suitable for insertion in a fractured elongate bone (12), comprising a stem (14, 114, 214, 314, 414, 514, 614) extending between a proximal end (16, 116, 216, 416, 516, 616) and a distal end (18, 118, 218, 418, 518, 618), characterised in that it comprises a plurality of elements (20, 120, 220, 320, 420, 520, 620) realised with at least a shape-memory material, a plurality of seats (19, 119, 219, 319, 419, 519, 619) formed in the stem (14, 114, 214, 314, 414, 514, 614) for housing said elements (20, 120, 220, 320, 420, 520, 620) and in that said elements (20, 120, 220, 320, 420, 520, 620) are suitable to take a first shape wherein they are retractably housed in the respective seats (19, 219, 219, 319, 419, 519, 619) and a second shape wherein they project from the respective seats (19, 219, 219, 319, 419, 519, 619).
2. Intramedullary nail (10) according to claim 1, characterised in that the seats of the stem (14) are made of a plurality of transversal slots, or elongate holes (19), which extends passing from one side of the stem (14) to the other.
3. Intramedullary nail (10) according to claim 1 or 2, characterised in that it comprises inserts (23), structurally independent from the stem (14), and comprising at least one of said shape-memory elements (20), each of said inserts (23) being suitable for insertion in a corresponding seat (19).
4. Intramedullary nail (10) according to any of the preceding claims, characterised in that the stem (14) is made of two united half-cylinders along the length.
5. Intramedullary nail (10) according to claim 3, characterised in that each insert (23) is inserted by pressure in the respective seat (19).
6. Intramedullary nail (10) according to claim 3, characterised in that each of said inserts (23) comprises two shape-memory elements (20), which are connected by means of a central connection element (22, 26).
7. Intramedullary nail (10) according to claim 6, characterised in that each insert (23) has substantially fork-like shape.

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8. Intramedullary nail (10) according to claim 2 and 7, characterised in that each fork-like insert (23) is suitable to be housed in a corresponding transversal slot (19), so that the two elements (20) are arranged on side opposite to the stem (14).
- 5 9. Intramedullary nail (10) according to claim 3, characterised in that the inserts (23) are flanked in succession along the length of the stem (14).
10. Intramedullary nail (10) according to claim 3, characterised in that the inserts (23) are distributed on the side surface of the stem (14) in correspondence with the proximal end (16) and the distal end (18).
- 10 11. Intramedullary nail (10) according to claim 3, characterised in that the inserts (23) are offset with respect to each other of 90° sexagesimal.
12. Intramedullary nail (10) according to claim 6, characterised in that the two elements (20) of each insert (23) comprise two opposite tabs (20), having a flexural memory.
- 15 13. Intramedullary nail (10) according to claim 3, characterised in that the inserts (23) is of the multilaminar type, i.e. it is realised by means of a plurality of overlapped foils of shape-memory material.
14. Intramedullary nail (10) according to claim 6, characterised in that the two elements (20) of the insert (23) are connected by means of a
20 cylindrical sleeve (26).
15. Intramedullary nail (10) according to claim 14, characterised in that on said cylindrical sleeve (26) two opposite grooves (28) are provided, being offset substantially of a right angle with respect to said two elements (20) and suitable to house at least partially the elements of a flanked
25 cylindrical sleeve (26).
16. Intramedullary nail (10) according to claim 12, characterise in that the tabs (20) on the surface facing outwards the stem (14) have a substantially sawtooth-like profile (32).
17. Intramedullary nail (10) according to claim 1, characterised in that it
30 comprises a tubular jacket (40) for sheathing the stem (14), having the function of retaining the shape-memory elements (20) in the first shape,

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i.e. in the close retractable position in the seats (19).

18. Intramedullary nail (10) according to claim 17, characterised in that the jacket (40) comprises a side wall (41) and a plurality of transversal elongate holes (42), made on the tubular wall (41).

5 19. Intramedullary nail (10) according to claim 18, characterised in that the jacket (40) and the stem (14) can be shifted with respect to each other from a first operative position during which the side wall (41) of the jacket (40) retains the shape-memory elements (20) in the first retractable shape in the seats (19), and a second operative position wherein the transversal
10 holes (42) of the jacket (40) are aligned in the seats (19) of the stem (14), so as to allow the arrangement of the elements (20) projecting from the respective seats (19).

20. Intramedullary nail (10) according to claim 19, characterised in that the shift relative to the jacket (40) with respect to the stem (14) occurs
15 along the axis of the nail (10).

21. Intramedullary nail (10) according to claim 19, characterised in that it comprises a control screw (45), suitable to be rigidly connected to a head portion (14a) of the stem (14) for controlling, by means of rotation around its own axis, the axial shift of the stem (14) with respect to the jacket (40).

20 22. Intramedullary nail (10) according to claim 21, characterised in that it comprises an internally hollow tube (50) suitable to be rigidly connected to a head portion of the jacket (40) and wherein the control screw (45) is backlash-like housed.

23. Intramedullary nail (110) according to claim 1, characterised in that
25 each element (120) is housed in a corresponding groove (122) having the function of seat (119) circumferentially developing along the side surface of the stem (14).

24. Intramedullary nail (210) according to claim 1, characterised in that each element (120, 220) is housed in a corresponding groove (122, 222)
30 having the function of seat (219) axially developing along the side surface of the stem (114, 214).

25. Intramedullary nail (110, 210) according to claim 23 and 24,

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characterised in that each element (120, 220) is fixed to a first end of the stem (114, 214) and it has a second free end (121, 21) suitable to be arranged, in correspondence with said second shape, outside the stem (14).

- 5 26. Intramedullary nail (110, 210) according to claim 23 or 24, characterised in that said groove (22, 122) has a U-shaped profile.
27. Intramedullary nail (410) according to claim 1, characterised in that each of said seats (419) is made of a narrow section (426, 427) made at the two ends of the stem (414), and in that said narrow section (426, 427)
10 is suitable to retractably house a cylindrical sleeve (422, 423) of shape-memory material.
28. Intramedullary nail (410) according to claim 27, characterised in that said cylindrical sleeve (422, 423) comprises a plurality of longitudinal slots (424, 425), the slots (424, 425) defining a plurality of fillets (424a, 425a),
15 said fillets (424a, 425a) taking a cask stave configuration projecting from the narrow section (426, 427) for the nail fixation to the bone.
29. Intramedullary nail (410) according to claim 28, characterised in that said slots (424, 425) are angularly equally spaced.
30. Intramedullary nail (410) according to claim 28, characterised in that
20 said narrow section (426) has a thread at the stem free, a retaining ring (428) of the cylindrical sleeve (422) being screwed on said thread.
31. Intramedullary nail (410) according to claim 28, characterised in that said narrow section (427) has a thread at the stem free, a retaining plug (429) of the cylindrical sleeve (423) being screwed on said thread.
- 25 32. Intramedullary nail (510, 610) according to claim 1, characterised in that said stem (514) is a cylindrical tube and in that said elements (520a) realised with a shape-memory material are two inserts (544), one of them placed at the proximal end (516) and the other at the distal end of the nail (510), said inserts being housed in correspondence with respective
30 portions with lowered section of the stem (514) forming said housing seats (519).
33. Intramedullary nail (510) according to claim 32, characterised in that

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each insert (544) is shaped as a cylindrical sleeve which comprises a plurality of longitudinal cuts (524), said cuts (524) cutting the thickness of the cylindrical sleeve of the insert (544) and defining a plurality of tongues (546) suitable to project with respect to the respective seat (519).

- 5 34. Intramedullary nail (610) according to claim 33, characterised in that said narrow section (626) with function of seat has an outer prismatic shape corresponding to an inner conjugated prismatic shape of the central hole of the cylindrical sleeve (622).
- 10 35. Intramedullary nail (610) according to claim 34, characterised in that said outer prismatic shape of said narrow section (626) and of said central hole of the cylindrical sleeve (622) is a regular octagonal prism.
36. An application method, in a fractured elongate bone (12), of an intramedullary nail (10, 110, 210, 310, 410, 510, 610) according to claim 1, characterised in that it comprises:
- 15 a location step of said nail (10, 110, 210, 310, 410, 510, 610) in said elongate bone (12), to mend the fracture;
- a step wherein the nail (10, 110, 210, 310, 410, 510, 610) is provided with a plurality of shape-memory elements (20, 120, 220, 320, 420, 520, 620) suitable to take a first shape wherein said elements are retractably
- 20 arranged in the seats formed in the stem of the nail (10) and
- an activation step of said plurality of elements (10, 110, 210, 310, 410, 510, 610) realised with at least a shape-memory material wherein the elements (20, 120, 220, 320, 420, 520, 620) take a second shape and they project with respect to the nail seats.